What's the problem? River management, education and public beliefs

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Abstract

This paper invokes the theory of planned behavior (TPB) as a diagnostic tool to explain an existing public education program's limited success at improving river water quality in the City of Perth, Western Australia. A reflective, client-driven research approach was used. A facilitated expert workshop defined an environmental problem (excess nutrients leaving gardens and entering waterways) and a desired behavior (residents purchasing environmentally sensitive fertilizer) to address the problem. A TPB-based belief elicitation survey captured respondents' beliefs regarding the desired behavior. The findings suggest respondents were aware of the links between purchasing environmentally sensitive fertilizer and river water quality. However, this behavior is compromised by the challenges in identifying appropriate products, product quality concerns and cost. Viewing the content of a public education program through the lens of the TPB reveals insights into how and why the program fell short in achieving one of its key behavioral change goals.

Key words: theory of planned behavior, human behavior in the environment, water quality, urban water catchment, river management

Introduction

Influencing public behavior is considered a core ingredient in the management of urban river water quality (Hurlimann et al., 2009). To this end, public education programs are often cited as an important part of the solution to influencing public behavior and reducing negative impacts on natural resources (Ahmed, 1990; Littlefair & Buckley, 2008; Najib, 1999; Odada et al., 2004; Rast & Holland, 1988). This paper critically examines the content of a particular public education program aimed at influencing a purchasing behavior, in this case to improve urban river water quality. In particular it draws on theory as a tool to explain why the program failed to fulfill expectations related to eliciting the desired behavior.

While direct methods of behavioral influence such as regulations, law enforcement and other forms of activity restraint can be used to varying levels of success, they can raise problems in relation to political acceptability, community support, social justice, and costly enforcement

and mitigation measures (Ahmed, 1990; Cullinane & Cullinane, 1999; Eaton & Holding, 1996; Holding & Kreutner, 1998; Steiner & Bristow, 2000). Consequently, natural resource managers commonly supplement direct and often expensive management actions with less obtrusive and less costly measures such as public education programs (Rast & Holland, 1988). One advantage of these programs is that they can reach a wide audience cost-effectively, with the aim of influencing people's decision making processes based on voluntary compliance (Beeton et al., 2005; Manning, 2003; Marion & Reid, 2007; van der Stoep & Roggenbuck, 1996). This in turn can relieve the pressures on limited regulatory and enforcement resources. Such programs can also provide political and public relations advantages in terms of paving the way for the later introduction of more restrictive measures by initially raising awareness and acceptance that a problem needs to be addressed (Jones & Sloman, 2002).

However, public education programs sometimes make the mistake of assuming it is general lack of knowledge, usually about consequences of a given behavior, that underpins the limited uptake of desired actions. Commonly, such programs then make the misguided assumption that raising public awareness and concern about the problem will lead to behavior change and mitigation of the problem. Such conclusions are often made without researching the extent or specifics of the knowledge deficit. Ham et al. (2008) note that a common problem with the content of education programs is that they are often based on the intuition, beliefs and personal experiences of those responsible for developing the programs. While expert or management intuition may at times be accurate, van der Stoep and Roggenbuck (1996) point out they may have little relevance to the general public at which the education is aimed, resulting in ineffective messages. Three general reasons underpin this. Firstly, the target audience may consist of a range of people with diverse beliefs, attitudes and

experiences. Secondly, beliefs are context-specific such that a person's beliefs regarding a specific behavior can vary according to the circumstances (Ham et al., 2009). Finally, Connelly and Knuth (2002) and Ham et al. (2008) explain that managers often think differently to the general public owing to their levels of knowledge, skill sets and focus on management objectives. Thus, their beliefs are unlikely to be representative of the general public. As a result, education programs that are founded on the experience, beliefs and knowledge of managers and other program staff can fall short of achieving behavior change (McKenzie-Mohr & Smith, 1999).

The aim of this paper is to use a proven theory of behavior as a diagnostic tool both to illustrate some shortcomings of a particular public education program aimed at fostering pro-environmental behavior and to elucidate an alternative pathway for the development of such programs.

Theory of planned behavior

A theoretical basis for communication efforts is important for developing message content that is more effective and persuasive on behavior (Marion & Reid, 2007). In this context, one of the most influential and widely applied theoretical frameworks of human behavior is Ajzen's (1991) theory of planned behavior (TPB) (Fig 1). This theory attempts to capture the complexity of human behavior within a structured and parsimonious framework of variables and constructs. According to the TPB, the primary determinants of any behavior are three categories of beliefs: behavioral beliefs about the positive or negative consequences a person might expect from performing a behaviour and his or her evaluations of those consequences; normative beliefs about whether important social referents would approve or disapprove of a behavior's performance and a person's motivation to comply with those opinions; and control

beliefs about the presence and power of factors that that might help or impede a person's attempts to perform the behavior. When combined, individual beliefs within each of these categories inform three corresponding cognitive constructs underlying intention to perform the behavior. These are a person's overall positive or negative evaluation of the behavior (attitude), his or her sense of social pressure to perform the behavior (subjective norm), and whether a person feels a sufficient level of control over its performance (perceived behavioral control). As a general rule, the more favorable the attitude and subjective norm, and the greater perceived behavioral control, the stronger a person's intention should be to perform the behavior. Finally, given a sufficient degree of actual control over the behavior, a person is expected to translate their intentions to actual behavior when the opportunity arises (Ajzen, 1991; Ajzen & Manstead, 2007). Based on this logic, behavioral, normative and control beliefs provide the foundations for developing persuasive messages aimed at influencing a specific target audience to behave in a certain way.

FIGURE 1 near here please

Fig. 1 The theory of planned behavior (adapted from Ajzen, 1991)

A key first step in an effective application of the TPB is a precise understanding of the nature of the problem and the behaviors that cause that problem. Using a classification by Hendee and Dawson (2002), problem behaviors can either be unskilled, uninformed, careless, unavoidable or illegal. As a general rule outlined by Roggenbuck (1992), only behaviors that are unskilled, uninformed, and to a lesser extent careless, can effectively be influenced through communication efforts. In these situations, an appropriately designed communication or education program can provide people with a cognitive motivation and/or skill set to

engage in desired target behaviors (Hendee & Dawson, 2002; Manning, 2003; Marion & Reid, 2007). Once the nature of the problem behaviors has been identified and their potential to be influenced by communication determined, alternative target behaviors can be articulated. These desired behaviors must be understood as observable events. Any observation of such an event takes place in a certain context and at a given point in time. Furthermore, most behaviors are directed at some target. It is therefore useful to think of a behavior as composed of four distinct components. These include: the *action* performed, the *target* the action is directed at, and the *context* and *time* in which it occurs (Fishbein & Ajzen, 2010). Using a purchasing behavior as an example, a desired behavior might be defined as buying (action) fair-trade coffee (target) at a local supermarket (context) over the next 12 months (time).

Once the target behavior has been identified, research is required with the audience managers want to influence to understand the determinants of the behavior and identify which of these should be carried forward into a communication intervention. Based on recommended procedures for applying the TPB to inform a communication intervention or program (e.g., Ajzen & Fishbein, 1980; Fishbein & Manfredo, 1992; Fishbein & Yzer, 2003; Ham et al., 2009; Reigner & Lawson, 2009; Sutton, 2002; van den Putte & Dhondt, 2005), this involves a two-stage formative research process. The first stage is an elicitation study that identifies the salient behavioral, normative and control beliefs relevant to the target behavior and audience. This typically involves asking a series of open-ended questions based on the belief categories of the TPB. By itself, this process provides managers with valuable terminology and insights into the range of "top of mind" beliefs that are relevant to the audience they want to influence, many of which might be different to their own belief systems. Once these salient beliefs have been identified, managers can then proceed with a second stage of formative

research, often referred to as a "belief measurement" study. In this stage, a fixed-item questionnaire is developed following TPB measurement procedures and administered to a second representative sample of the target audience. Respondents are asked to rate the strength and importance of the salient beliefs (often using a modal set) identified from the elicitation study. Analysis of this data typically involves statistical comparisons of cross-product belief scores between performers and non-performers of the target behaviour. Based on the logic of the TPB, beliefs that appear most different between the two groups should be targeted in an intervention. In combination, these two formative phases of research provide managers with a means of identifying and targeting beliefs associated with a given behavior that are more likely to influence the target audience than communication guided by guesswork or managers' intuition (Brown et al, 2010).

Unlike other published studies, this paper does not report on how the TPB was used to inform and evaluate a communication intervention. Instead, the paper uses TPB as a reflective tool with which to revisit education programs associated with the Swan-Canning river system in Perth, Western Australia that were designed to address a set of persistent environmental management problems. The perceived ineffectiveness of such programs in influencing behaviors led to the engagement of the authors to critically examine the pre-existing education programs through the TPB lens.

Consequently, the paper first provides the environmental and public education context of the research, before turning to the methods and results of two phases of research. Phase 1 facilitated expert input to clearly select and define a key management problem and a desired (target) behavior aimed at addressing the problem. Phase 2 was informed by the TPB and involved an elicitation study to identify the key beliefs of the target audience about the target

behavior as defined by the experts (a belief measurement phase is not reported in this paper, as the focus is more on undertaking a "stock take" of salient beliefs underlying the behavior) . These two phases revealed differing views among managers (phase 1), differences between management's views and the public's beliefs (phase 2), and insights into how these differences contributed to the relative ineffectiveness of the (pre-research) education program.

Context: the Swan-Canning river system and the public education program

The Swan-Canning river system is a major waterway in the southwest of Western Australia. Its lower reaches are situated on a flat, sandy coastal plain within Perth, the capital city and main population centre of Western Australia. Perth's population of 1.6 million people resides in sprawling urban residential areas dominated by detached dwellings. The relatively shallow river system functions as a recreation resource, transport corridor, irrigation source, drinking water source and recreational fishery for Perth's population. The river system's water catchment area is about 120,000 km^2, a significant portion of which lies within the Perth urban area. The river system is fed by winter rain causing stream flow from tributaries as well as from significant groundwater sources. Perth's urban residential blocks commonly have gardens consisting of lawns and exotic plants requiring significant amounts of water and nutrients to survive the dry, hot and sandy Perth conditions (Weller, 2009).The Swan Coastal Plain sandy soils are highly permeable, meaning that water and nutrients can rapidly move through the soils and into water bodies and streams (Gerritse, 2000; Weaver, 1993).

During the 1990s, concerns were raised regarding the Swan and Canning Rivers' poor water quality associated with high nutrient levels (eutrophication) in urban areas. Eutrophication directly affects water quality and ecosystem health and also triggers algal blooms (Rast &

Holland, 1988). Algal blooms in particular can affect the amenity of the river, negatively impacting on recreational and commercial use, and present a public health hazard through production of toxins and pathogens. As a result, the Swan-Canning Cleanup Program (SCCP) was launched in 1999. This multi-faceted program aimed to improve water quality and reduce the incidence of toxic algal blooms occurring in the Swan-Canning river system by reducing nutrient discharges from urban areas (Oceanica Consulting, 2005). One key aspect of this program of particular relevance to the present paper involved public education to raise community awareness regarding catchment and river management issues, and what residents could do to help in terms of engaging in a range of desirable behaviors. Examples of such education efforts included school and community education programs linked to practical action (training in water quality monitoring, planting activities, rubbish removal and so on), and workshops designed to educate householders about successfully growing gardens in Perth using minimal fertilizer and water.

Although the SCCP has operated since 1999, nutrient levels in the rivers remain problematic and incidents of toxic algal blooms still occur. This suggests that the education programs borne from the action plan, combined with other management measures, have not alleviated the problem. While a range of issues may contribute to the success or failure of communication efforts, a peer review of the SCCP education programs raised concerns regarding the absence of preliminary research concerning the “barriers and benefits” related to the public adopting certain desired behaviors promoted by the program (Oceanica Consulting, 2005).

Collier and Smith (2009), who also use theory reflectively to explain program failure, note that public education programs that lack an adequate foundation of understanding regarding

241 the public audience's knowledge, skills and ability to change behavior will ultimately fail to
242 achieve their objectives. The absence of this form of preliminary research is certainly not
243 unusual. Similar concerns have been voiced in the development and evaluation of
244 communication efforts related to other waterways (e.g., Fogarty et al., 2007; Howard &
245 McGregor, 2002) and in tourism, national park and other recreational settings (e.g.,
246 Ballantyne & Hughes, 2006; Beeton et al., 2005; Ham & Krumpe, 1996). The present paper
247 goes beyond these to draw on theory, specifically the TPB, to explain these failures.
248
249 According to Ham and Krumpe (1996), there are essentially two sides to any communication
250 effort. On the one hand, there is a core problem identified by natural resource managers based
251 on their knowledge and expertise. In cases where the problem is caused by human behavior,
252 the problem provides the motivation for initiating a communication campaign. On the other
253 side is the specific target audience who are directly associated with the problem because of
254 their actions or inactions, and thus who become the focus of communication efforts. For any
255 communication campaign to be effective, the content must not only be appropriate to solving
256 the problem, it must also be relevant to that audience (and move beyond simplistic
257 knowledge-deficit assumptions that raising awareness will lead to behavior change). If the
258 problem is not clearly defined, or the communication content is not directly relevant to the
259 target audience, the effectiveness of any communication endeavor is likely to be
260 compromised.
261
262 In light of these two pre-requisites for effective communication, this study revisited the
263 environmental management issues and associated problem behaviors that provided the
264 original rationale for the SCCP education programs, and focuses on one particular problem
265 and target behavior to examine using the TPB as a post-hoc evaluation tool. Beginning with

an expert workshop to define the problem and desired behavioral solution, the study then undertook a TPB-informed public survey to inventory the salient beliefs associated with the target behavior. Together these two phases help to ascertain why some aspects of the education programs were ineffective and the role of behavioral theory in informing and diagnosing communication efforts.

Methods for Phase 1: facilitated problem identification with experts

A half day problem identification workshop was held in Perth in April 2008 with 16 key experts associated with managing the Swan-Canning river system, facilitated by the authors. The experts were nominated by State Government agencies and community based catchment management groups responsible for managing the rivers and water in the Perth area. The workshop aimed to reach a consensus on the priority environmental management problems in the Swan-Canning river system. A group consensus (modified Delbecq or Nominal Group Process) approach was used that encourages equal participation among group members for the purpose of identifying and ranking issues. Experts were advised to restrict their focus to problem public behaviors that were unskilled, uninformed or careless and therefore appropriate for a public education program, consistent with the requirements of TPB methods (Hughes et al., 2009; Ham et al., 2009).

The expert group was presented with a hypothetical scenario about identifying the most pressing problems to be addressed in the first year of a five year river management plan. The group of experts individually and silently listed problems they considered most pressing in relation to the Swan-Canning river system on paper. The problems, related behaviors, target audience groups, locations and desired behaviors were then listed on a whiteboard matrix as part of a facilitated group discussion exercise.

Participants then prioritized each problem by individually distributing a total of 100 points among them. Each participant was given a paper copy of the white board problem matrix for this exercise. Two rules determined the distribution of points: all 100 points had to be allocated, and no single problem could be allocated more than 50 points by an individual. This was followed by another round of facilitated group discussion, whereby each group member entered their points allocations onto the white board. From this process, the most pressing problem was identified based on the summed points for each problem.

Further meetings between the authors and members of the expert group were required to specifically define the problem and desired target behavior. This included clearly defining a specific location where the problem behavior occurs, target group (audience) causing the problem, when the behavior occurs and a specific target behavior the experts would like that group to perform to alleviate the problem.

Results for Phase 1

A total of 23 river management problems were identified during the expert workshop (Table 1). However, the issue of "excessive nutrients from home gardens entering waterways", caused mainly by domestic fertilizer use, was allocated almost 100 points more than any other problem listed. Specific behaviors, identified by the experts, contributing to this problem included domestic gardeners buying 'wrong' types of fertilizer products; not following product instructions on the bag; over-watering; applying fertilizer at the wrong time of year; and using plant species that require heavy fertilizing. Further group discussion eventually identified the behavior contributing to the problem to be "the type of fertilizer purchased by the public at garden retail stores for home use." The target behavior determined

316 to help alleviate the problem was for ‘home gardeners to buy *(action)* environmentally
317 sensitive fertilizers *(target)* from garden retail stores (*context)* the next time they need
318 fertilizer *(time)*.’
319
320 TABLE 1 near here please
321
322 When specifically defining the desired behavior, the experts were asked to come to an
323 agreement on what types of fertilizer products were environmentally sensitive by considering
324 the numerous complex factors relating to impacts of domestic fertilizer use on water quality.
325 These have been documented by a number of authors (Barth, 1995; Clayton, 2007; Fogarty et
326 al., 2007; Howard & McGregor, 2002; McDade, 2008; Oceanica Consulting, 2005; Robbins,
327 2007; Werner, 2003; South East Regional Centre for Urban Landcare, 2008), highlighting
328 how the solubility and nutrient content (in particular nitrogen and phosphorous) of common
329 domestic fertilizers can cause eutrophication and degrade water quality when not applied and
330 managed properly. Undesirable flow-on effects include health problems (extending to deaths
331 in some instances) for humans, native flora and fauna, and livestock, replacement of desirable
332 species with less desirable ones, taste and odor problems, reduced recreational amenity, and
333 economic losses to industries reliant on these negatively impacted habits and water systems.
334
335 In attempting to achieve widespread agreement on environmentally sensitive product types,
336 some of the experts focused on particular product characteristics such as nutrient
337 concentration and water solubility, while others pointed out additional elements that could
338 still cause problems. For example, a low water-soluble fertilizer may still contain high levels
339 of phosphates and nitrates, even though it may be retained in the soil for a longer period.
340 Fertilizer products with low phosphate content may have high levels of nitrates or other

nutrients and vice versa. These issues were further complicated by the fact that many products have both desirable and undesirable ingredients and characteristics, meaning none were ideal. After extensive discussion and some disagreement, a list of commercially available fertilizer products was eventually agreed on by the expert group as being a 'best fit' in terms of environmental sensitivity. This included products where the number of desirable characteristics outweighed the undesirable ones.

Interpretation of results for Phase 1 in relation to the existing public education program

The results of the nominal group consensus expert workshop identified and ranked a range of Swan-Canning river system management problems. It is clear that expert opinion still considers excess nutrients from home gardens negatively impacting on river water quality to be by far the most pressing problem. The experts identified a range of behaviors contributing to this problem and determined that Perth home owners buying environmentally sensitive fertilizer (ESF) was a key part of alleviating the problem.

It needs reiterating that this type of discussion and consensus on exactly what behaviors should be targeted to address the environmental problem did not occur prior to the development of SCCP's 1999 public education program. This may explain, at least in part, the finding of the present study's problem identification workshop that, some ten years later, "water quality problems caused by excessive nutrients from home gardens entering waterways" is still the most pressing issue in the Swan-Canning river system. As the source of nutrients is dispersed across the Perth urban area, it is referred to as non-point source 'cultural eutrophication' and can have significant ecological, economic and social impacts (Rast & Holland, 1988). Mitigation of problems linked to non-point source cultural

eutrophication tend to rely mainly on public education because legislative and engineering responses are either difficult to implement or too costly.

It is also important to note that while purchasing ESF was agreed as a target behavior to address this problem, the expert group was unable to come to a consensus on a specific definition of an ESF. Furthermore, they had difficulty agreeing on what commercial products might fall into this category. This indicates significant expert uncertainty regarding identification of ESF retail products. The lack of success of the public education program thus may be the result, at least in part, of an absence of clarity as to what action residents can do, and in particular which products they can buy in order to help address the Swan-Canning river system water quality problem.

Methods for Phase 2: target audience belief elicitation

Following TPB procedures, a belief elicitation survey was conducted on-site at a representative case study location (a local garden retail centre) nominated by the expert panel. The store was selected based on the broad demographic range of people who purchase garden products from the location, and hence considered to be a sub sample of the Perth population. A purposive sampling technique was used during the belief elicitation phase where-by all people who were observed to have purchased fertilizer were approached with a request to participate in the survey as they exited the store. A number of interviewers were simultaneously employed such that all people purchasing fertilizer at the store could be approached during the sampling period.

The survey instrument involved a face-to-face interview using an open-ended question format, administered by interviewers trained in TPB techniques. Consenting survey

participants were asked the following paired open ended questions grouped according to the TPB framework (Fig 1):

Behavioral beliefs

1a.What do you think are the good things that could occur if you buy an environmentally sensitive fertilizer from this store today for your home garden?

1b.What do you think are the bad things that could occur if you buy an environmentally sensitive fertilizer from this store today for your home garden?

Normative beliefs

2a. Who do you think would approve of you buying an environmentally sensitive fertilizer from this store today for your home garden?

2b.Who do you think would disapprove of you buying an environmentally sensitive fertilizer from this store today for your home garden?

Control beliefs

3a.What factors make it easy for you to buy an environmentally sensitive fertilizer from this store today for your home garden?

3b What factors make it difficult for you to buy an environmentally sensitive fertilizer from this store today for your home garden?

Each question pair related to one of the underlying belief categories of the TPB. Behavioral belief questions asked respondents what they believed were the positive and negative consequences of purchasing ESFs, normative beliefs asked them about feelings of social pressure to purchase (or not) such products, while control beliefs sought to identify factors

that made purchasing ESFs easy or difficult. The belief responses were written down by the interviewers using the respondents' own words. Collectively, data gathered from these questions provided managers with a theoretically informed set of salient beliefs regarding the target audience's understanding and motivation to engage in the target behavior, allowing them to revisit previous communication efforts to formatively determine whether past messages had engaged with the full gamut of truly pertinent beliefs. The survey also included an additional open-ended question on what products in the store the target audience considered to be ESF and some basic demographic information.

In accordance with TPB methods, a theoretical saturation approach was adopted for the belief elicitation. Interviews of separate individuals performing the target behavior of purchasing fertilizer were conducted over successive days until no new types of responses to the questions were apparent in the sample (Ham et al., 2009). Once achieved, the complete range of beliefs of the target audience regarding the behavior was considered to have been elicited. Belief responses for each question were grouped by similar meaning.

Results for Phase 2

The belief elicitation survey gathered data on the beliefs linked to the action of purchasing ESF (target) at the garden retail store case study site (context) when the respondent needed more fertilizer (time). Theoretical saturation was achieved after 40 on-site interviews. Interviewers approached 72 people who had purchased fertilizer during the sampling period until saturation was achieved (56% response rate). Reasons given for not participating included not having enough time or simply not being interested. Table 2 presents the aggregated results of the elicitation survey.

TABLE 2 near here please

In terms of the behavioral belief component of the TPB framework and the positive outcomes of purchasing ESFs, respondents believed they would have less impact on the rivers and were safer for people and animals. In terms of the negative attribute of this behavior, respondents believed these products may not work as well on their gardens. Normative beliefs did not feature prominently in the survey response. However, respondents raised a number of control beliefs regarding difficulties with purchasing such products. In particular, respondents indicated ESFs were hard to find in the store. According to respondents, difficulty with locating products was partly owing to the lack of consistent, accurate and distinctive product labeling and an absence of sufficient information and knowledgeable staff in the garden retail outlet. Respondents also commonly held the control belief that ESFs cost too much.

The open-ended question asking respondents what products they considered to be an ESF added another perspective to the belief that ESFs were hard to find in the store. The most common response was “I don’t know”, followed by responses indicating that they believed the products labeled as “organic” or “natural” and manure-based products to be environmentally sensitive.

Interpretation of results for Phase 2 in relation to the existing public education program

In terms of the TPB, the main determinants of performing the target behavior appear grounded mainly in issues of control with some influence from behavioral beliefs. The positive behavioral beliefs regarding ESFs suggests that the public education program may have had some success in building awareness among respondents about the impacts of domestic fertilizer use on water quality and the benefits of using ESFs to reduce these

464 impacts. However, negative behavioral belief elements regarding ESFs being less effective
465 than other fertilizer types may function as a barrier to the behavior. Beliefs about poor
466 effectiveness most likely relate to the ESFs products having low nutrient content and low
467 water solubility. While these characteristics are suitable for Perth's sandy soil conditions and
468 native plants, they may be inadequate for Perth gardens that often include exotic plants and
469 lawns that require large quantities of nutrients and water (Weller, 2009).
470
471 Primarily, the results indicate the ability to perform the target behavior is grounded in the
472 control element of the TPB regarding an inability to identify ESFs in the first place. An
473 inability to identify ESFs amongst the myriad of other products in the store appears to be
474 associated with a lack of knowledge about what products are environmentally sensitive. For
475 example, the survey results show that many respondents considered manure and manure
476 based products to be ESFs. In reality, manure based products have significant detrimental
477 water quality effects. It is interesting to note that experts included in Phase 1 of the study also
478 struggled with this question. Thus the difficulty in identifying ESF products in the store is
479 likely associated with confusion about what types of product fall into this category.
480
481 Interestingly, the control belief that ESFs are costly is likely linked to the behavioral belief
482 that they are less effective. In terms of the link between ineffectiveness and costliness, the
483 behavioral economics literature notes that while cost is a factor influencing purchase, it is not
484 the only, or indeed primary, factor. This is generally because purchasing behavior is not
485 solely based on rational economic thinking (Arana & Leon, 2008; Duxbury et al., 2005).
486 Other product characteristics such as quality, reliability and appearance, as well as brand
487 loyalty, can have significant influence on product selection (Koppel et al., 2008; Yamamoto
488 et al., 2008). Price is linked to perceived quality where more expensive products within a type

489 are generally associated with better quality (Vlaev et al., 2009). It could be assumed that low
490 quality is generally associated with lower cost. The belief that ESFs cost too much may
491 therefore be associated with the belief that they are lower in quality, in that they may not
492 work as well as other fertilizer products. Thus, even if a respondent is able to identify an ESF
493 product in the store, the belief they may not work so well may lead to the belief that they cost
494 too much.
495
496 **Discussion and conclusion**
497 This paper sought to use the TPB as a diagnostic tool to explain the limited success of the
498 SCCP public education program in fostering pro-environmental behavior. This information
499 can then be used to elucidate an alternative pathway for the development of such programs.
500 The expert workshop phase of the study identified the core problem and alternative desired
501 behaviors from the point of view of the experts and managers. This reinforced the notion that
502 the SCCP public education program designed by managers and experts to reduce nutrients
503 entering the Perth waterways was still highly relevant, but was falling short with respect to
504 practical effectiveness.
505
506 The belief elicitation phase of the study addressed the beliefs associated with the desired
507 behavior from the perspective of a sample of residents who are directly associated with the
508 problem and who are the target of education efforts. The approach pinpoints factors that help
509 explain the limited success of the public education program. These findings point to
510 significant confusion among respondents about which of the many fertilizer products
511 available are environmentally sensitive. The results also highlight the need to address beliefs
512 about the limited effectiveness and cost of ESFs when used on home gardens.
513

Interestingly, the results of the elicitation survey suggest that the SCCP program has been effective in educating respondents about the links between home gardening and river water quality. However, because the original education program design was based on the intuition of experts, with a focus on management outcomes, it appears to have overlooked the fundamental issue of knowing what product type to buy. The program also did not address respondent beliefs that ESFs are lower quality compared with other products. These oversights arguably resulted in a lack of behavior change on the part of the public as a tool to help reduce nutrient impacts on river water quality. This highlights the dangers of relying solely on the intuitive judgment of managers or experts in the design of public education programs as noted by Collier and Smith (2009), Ham et al. (2008), van der Stoep and Roggenbuck (1996) and others.

The lack of information on what fertilizer product types to purchase is also likely associated with disagreement among the experts themselves about what constitutes an ESF product. Disagreement among groups of resource managers was noted by Connelly and Knuth (2002) as a significant impediment to effective management. In the present study, this has resulted in fertilizer information contained in educational programs that is either vague or incomplete. It seems reasonable that if the experts have difficulty in identifying ESF products, the target audience should not be expected to be able to do so. Consequently, while awareness of the water quality issues appears to have been effectively communicated, the target audiences are likely not receiving clear messages regarding what specific action to do that could alleviate the problem.

With hindsight, the SCCP education program should have included clear information enabling the public to readily identify ESF products in a retail store. In addition to simply not

knowing which products are ESFs, the results suggest the respondents are interpreting terminology and labeling in a manner not representative of the actual product characteristics in a water quality context. Thus the education program could also include a guide for interpreting labeling and what it actually means in terms of the impacts on water quality. This could also be complemented with a certification system where products that meet water quality impact minimization specifications are identified as environmentally sensitive with a logo on the product label. Furthermore, the education program could perhaps more explicitly address quality concerns by emphasizing what specific types of fertilizer product are most appropriate for the Perth conditions. In other words, had the SCCP education program been preceded by research such as a TPB-based study, it may well have better addressed the barriers to public action that could reduce nutrient flows into the Swan-Canning river system and improve water quality.

As this research study demonstrates, using public education programs to influence behavior is not a simple undertaking. It requires not only a sound knowledge of the science of environmental management, but a research-based understanding of how public beliefs influence their behavioral responses to environmental issues. The TPB can effectively function to provide that understanding as well as function as a diagnostic tool for evaluating education program performance. Such theory-driven research can take the guess work out of both the design and the evaluation of education programs for natural resource managers.

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